



U N I T E D S T A T E S N A V A L O B S E R V A T O R Y

C I R C U L A R N O. 1 4 6

U. S. Naval Observatory, Washington, D. C. 20390

April 19, 1974

ASTRONOMICAL DATA IN MACHINE READABLE FORM

by

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This *Circular* supersedes *Circular* 128, 29 May 1970. It contains a revised list, with occasional changes in item number, of the astronomical data available in machine readable form from the U. S. Naval Observatory. Duplicates of these data, on punched cards or magnetic tape, will be made in response to requests from astronomical observatories or other scientific laboratories. Inquiries relative to procurement of copies should be directed to the Superintendent, U. S. Naval Observatory, Washington, D. C. 20390.

Sun

(1) *The American Ephemeris and Nautical Almanac*

- (a) Through 1980: Daily values at 0^h E. T. of: apparent right ascension and declination, radius vector, semidiameter. Equation of time through 1967; ephemeris transit beginning 1968 (365 cards per year).
- (b) 1968 - 80: Daily values at 0^h E. T. of: longitude (mean equinox of year), reduction to apparent longitude, latitude (ecliptic of 1950.0, year, and date), horizontal parallax, precession in longitude, nutation in longitude and obliquity of ecliptic (365 cards per year).
- (c) Ephemeris for physical observations, through 1978 (365 cards per year).

(2) *The Nautical Almanac*, right hand pages; Greenwich hour angle, apparent declination, hourly through 1976 (8,800 cards per year).

(3) *Astronomical Papers*, Vol. XIV

- (a) left hand pages: spherical and rectangular coordinates of the Earth - Moon barycenter referred to 1950.0, 1800 - 2000. Magnetic tape only, available in 4, 10, and 20 day intervals.
- (b) right hand pages: geocentric spherical (referred to date) and rectangular (referred to 1950.0) coordinates of the Sun, 1800 - 2000. Magnetic tape only.

(4) Apparent longitude, referred to true equinox of date

- (a) for every 10 days, 100 B. C. - A. D. 1800 (7,000 cards),
- (b) daily, 1800 - 2000. Magnetic tape only.

(5) *Publications of the U. S. Naval Observatory*

Positions of the sun, moon and planets observed with the Six-Inch Transit Circle

(a) Vol. XVI

- (1) Part I, 1925 - 1941 (7,615 cards).
- (2) Part III, 1941 - 1949 (2,565 cards).

(b) Vol. XIX

- (1) Part I, 1949 - 1956 (3,043 cards).
- (2) Part II, 1956 - 1962 (3,260 cards).

Also available on magnetic tape; blocked one page per record.

(6) *U. S. Naval Observatory Circulars* Nos. 103, 105, 108, 115, 118, 124, 127 and 143

Positions of the sun, moon and planets observed with the Six-Inch Transit Circle between 1956 and 17 July 1969 (7,240 cards).

(7) *U. S. Naval Observatory Circular* No. 138

Geocentric solar data for each day in 1978 at 0^h U. T., referred to equator and equinox of date. Declination, equation of time, semidiameter and distance (370 cards):

Also see Miscellaneous: *The Nautical Almanac*, right hand pages and *The Air Almanac*.

Moon

- (1) *The American Ephemeris and Nautical Almanac and Improved Lunar Ephemeris*, 1952 - 1959
 - (a) Apparent longitude and latitude, semidiameter, horizontal parallax, ephemeris transit, for every half day through 1971. Includes nutation and aberration (730 cards per year). 1972 - 1979 magnetic tape only.
 - (b) Apparent right ascension and declination, horizontal parallax, hourly through 1971 (8,800 cards per year). 1972 - 1979 magnetic tape only.
 - (c) Ephemeris for physical observations, through 1978 (365 cards per year).
- (2) *The Nautical Almanac*, right hand pages: Greenwich hour angle, apparent declination, horizontal parallax, sidereal time, hourly through 1976 (8,800 cards per year).
- (3) Geocentric equatorial rectangular coordinates in units of Earth's radius, referred to 1950.0,
 - (a) For every half day, 1952 January 1 through 1971 July 4. Magnetic tape only.
 - (b) For every quarter day, 1971 January 1 through 31 December 1980, as published in *U. S. Naval Observatory Circular* No. 140, Rectangular Coordinates of the Moon, 1971 - 1980. Magnetic tape only.
- (4) Longitude, latitude, horizontal parallax, referred to mean equinox of date for every half day through 1971. Includes aberration except for the term, $+0''.018 \cos(l - 2D) + 0''.007 \cos 2D$ of the aberration (730 cards per year).
- (5) Improved Lunar Ephemeris
 - (a) $j = 0$ (see p. vii, *American Ephemeris and Nautical Almanac*, 1971), on magnetic tape only, three reels: (1) 1925 - 1950, (2) 1950 - 1975, (3) 1975 - 2000.
 - (b) Correction to apply to (a) to obtain $j = 1$ (see p. vii, *American Ephemeris and Nautical Almanac*, 1971), on magnetic tape only, three reels: (1) 1925 - 1968, (2) 1968 - 1980, (3) 1980 - 2000.
 - (c) $j = 2$ (see p. vii, *American Ephemeris and Nautical Almanac*, 1972), on magnetic tape only, ten reels: (1) 1800 - 1819, (2) 1820 - 1839, (3) 1840 - 1859, (4) 1860 - 1879, (5) 1880 - 1899, (6) 1900 - 1919, (7) 1920 - 1939, (8) 1940 - 1959, (9) 1960 - 1979, (10) 1980 - 1999.
- (6) Apparent longitude and latitude, referred to true equinox of date, daily, 300 B. C. - A. D. 2074. Magnetic tape only.
- (7) *Publications of the U. S. Naval Observatory*

Positions of the sun, moon and planets observed with the Six-Inch Transit Circle

 - (a) Vol. XVI
 - (1) Part I, 1925 - 1941 (7,615 cards).
 - (2) Part III, 1941 - 1949 (2,565 cards).
 - (b) Vol. XIX
 - (1) Part I, 1949 - 1956 (3,043 cards).
 - (2) Part II, 1956 - 1962 (3,260 cards).

Also available on magnetic tape; blocked one page per record.

 - (3) Part III, 1925 - 1968. Magnetic tape only.
- (8) *U. S. Naval Observatory Circulars* Nos. 103, 105, 108, 115, 118, 124, 127 and 143

Positions of the sun, moon and planets observed with the Six-Inch Transit Circle between 1956 and 17 July 1969 (7,240 cards).

Also see Miscellaneous: *The Nautical Almanac*, right hand pages and *The Air Almanac*.

Planets

(1) *The American Ephemeris and Nautical Almanac*

- (a) Apparent right ascension and declination, semidiameter, horizontal parallax, true distance from Earth, ephemeris transit, daily through 1967. All planets except Pluto (365 cards per year per planet).
- (b) Apparent right ascension and declination, true distance from Earth and ephemeris transit, daily, 1968 - 1980, inclusive. All planets except Pluto (365 cards per year per planet).
- (c) Astrometric right ascension and declination, horizontal parallax, true distance from Earth, ephemeris transit of Pluto, for every 4 days through 1971 (92 cards per year).
- (d) Heliocentric longitude and latitude, radius vector, orbital longitude, daily motion of orbital longitude of Jupiter and Saturn, referred to mean equinox and ecliptic of date, for every 10 days, 1960 May 7 through 1982 January 31 (801 cards per planet).
- (e) Heliocentric longitude and latitude, radius vector, orbital longitude, daily motion of orbital longitude of Uranus, Neptune and Pluto, referred to mean equinox and ecliptic of date, for every 40 days, 1959 December 18 through 1982 (205 cards per planet).
- (f) Ephemeris for physical observations of Mercury and Venus through 1976; Mars, Jupiter and Saturn through 1978.

(2) *Astronomical Papers*, Vol. XII, *Coordinates of the Five Outer Planets*, 1653 - 2060

- (a) 40 - day values (3,721 cards per planet).
- (b) 10 - day values, subtabulated from 40 - day coordinates, by date and planet. Magnetic tape only.
- (c) 40 - day values, by date and planet. Magnetic tape only.
- (d) 40 - day values, reintegrated carrying more significant figures. Magnetic tape only.

(3) Heliocentric coordinates of the five outer planets, 1800 - 2000, based on new mass values and a new fit to observations. Summary of basis in *Astronautics and Aeronautics*, August 1972, p. 63. Magnetic tape only.

(4) *Astronomical Papers*, Vol. XV, Part III, *Heliocentric Coordinates of Venus*, 1800 - 2000

- (a) 4 - day values (41,000 cards).
- (b) 4 - day values, blocked 10 to a record. Magnetic tape only.
- (c) 10 - day values, unblocked. Magnetic tape only.
- (d) 20 - day values, blocked 10 to a record. Magnetic tape only.

(5) *U. S. Naval Observatory Circulars* Nos. 90 and 95

Provisional ephemeris of Mars based on Clemence's theory. Heliocentric equatorial rectangular coordinates, referred to mean equinox and equator of 1950.0, for every 4 days (a) 1800 - 1950 (tape only), (b) 1950 - 2000 (2,350 cards).

(6) *U. S. Naval Observatory Circular* No. 96

Geocentric distance and velocity of Venus referred to 1950.0, daily, 1960 - 1970, inclusive (365 cards per year).

(7) *U. S. Naval Observatory Circular* No. 98

Physical ephemeris of Mars based on a position of the north pole of $\alpha = 316^\circ 55' + 0^\circ 006533 (t - 1905.0)$, $\delta = +52^\circ 85' + 0^\circ 003542 (t - 1905.0)$, computed at a two day interval for sixty days centered at each opposition from 1877 - 1967 (5,246 cards).

(8) *Planetary Co-ordinates*, 1960 - 1980

- (a) Heliocentric equatorial rectangular coordinates of Mercury, referred to 1950.0, for every 5 days (365 cards).
- (b) Longitude, latitude, radius vector and equatorial rectangular coordinates of Venus, Earth and Mars, referred to 1950.0, for every 10 days (769 cards per planet).

Planets

- (9) Heliocentric equatorial rectangular coordinates and first derivatives of Venus and Earth-Moon barycenter, referred to 1950.0 daily, 1960 - 1970, inclusive.
- (a) Coordinates (365 cards per year).
 - (b) Derivatives (365 cards per year).
- (10) Longitude, latitude and radius vector of Mercury, Venus and Mars, daily through 1980 (365 cards per year per planet).
- (11) (a) Heliocentric equatorial rectangular coordinates of all planets except Mercury, referred to 1950.0, by date and planet, for every 10 days 1800 January 4.5 through 2000 December 2.0. Venus, same as 3 (c); Earth-Moon barycenter, same as Sun, 3 (a); Mars, unpublished Herget integration; outer planets, same as 2 (b). Magnetic tape only.
- (b) Same as 11 (a) but in reverse chronological order. Magnetic tape only.
- (12) *Publications of the U. S. Naval Observatory*
- Positions of the sun, moon and planets observed with the Six-Inch Transit Circle
- (a) Vol. XVI
 - (1) Part I, 1925 - 1941 (7,615 cards).
 - (2) Part III, 1941 - 1949 (2,565 cards).
 - (b) Vol. XIX
 - (1) Part I, 1949 - 1956 (3,043 cards).
 - (2) Part II, 1956 - 1962 (3,260 cards).
- Also available on magnetic tape; blocked one page per record.
- (13) *U. S. Naval Observatory Circulars* Nos. 103, 105, 108, 115, 118, 124, 127 and 143
- Positions of the sun, moon and planets observed with the Six-Inch Transit Circle between 1956 and 17 July 1969 (7,240 cards).
- (14) *U. S. Naval Observatory Circular* No. 106
- Rectangular co-ordinates of Mercury, 1800 - 2000. Magnetic tape only.
- (15) *U. S. Naval Observatory Circular* No. 139
- Astrometric Ephemeris of Pluto, 1970 - 1990. Magnetic tape only.
- Also see Miscellaneous: *The Nautical Almanac*, left hand pages and *The Air Almanac*.

Minor Planets

- (1) *The American Ephemeris and Nautical Almanac*
- (a) Astrometric right ascension and declination, true distance from Earth, ephemeris transit of Ceres, Pallas, Juno, Vesta, daily through 1971 (365 cards per year per planet).
 - (b) For 1968 - 1979. Magnetic tape only.
- (2) *Astronomical Papers*, Vol. XI, Part IV and Vol. XVI, Part III
- Heliocentric equatorial rectangular coordinates of Ceres, Pallas, Juno and Vesta, referred to 1950.0 for every 20 days, 1920 - 1960 (770 cards per planet); for every 10 days, 1960 - 1980 (770 cards per planet).
- (3) *Astronomical Papers*, Vol. XX, Part II
- Heliocentric equatorial rectangular coordinates of Ceres, Pallas, Juno and Vesta, referred to 1950.0 for every 10 days, 1928 - 2000. Magnetic tape only.

Star Catalogues

Available

(1) *Publications of the United States Naval Observatory*

- (a) Vol. VIII (1,201 cards).
- (b) Vol. IX
 - (1) Part I (4,526 cards).
 - (2) Part IV (196 cards).
- (c) Vol. X, Part I (368 cards).
- (d) Vol. XI
 - (1) Catalogue of 215 Stars (215 cards).
 - (2) Catalogue of 2,499 Stars (2,499 cards).
- (e) Vol. XIII
 - (1) (10,571 cards).
 - (2) Appendix II (818 cards).
- (f) Vol. XIV
 - (1) Part I (3,520 cards).
 - (2) Part II (1,248 cards).
 - (3) Part III (2,094 cards).
- (g) Vol. XV, Part V (5,446 cards).
- (h) Vol. XVI
 - (1) Part I
 - (a) Stars for 1925.0 (2,383 cards).
 - (b) Stars for 1950.0 (1,536 cards).
 - (2) Part III (5,216 cards).
- (i) Vol. XIX,
 - (1) Part I (5,965 cards).
 - (2) Part II (2,685 cards).

Also available on magnetic tape; blocked one page per record.
- (j) Vol. XXI, Photoelectric Catalogue. Magnetic tape only.

(2) *Astronomical Papers*, Vol. XIII, Part III, N30 (5,268 cards).

(3) *Astronomical Papers*, Vol. VIII, Part II (1,596 cards).

(4) *Astronomical Papers*, Vol. X, Part II (3,539 cards).

(5) Boss, *Albany General Catalogue* (33,342 cards).

(6) Cross References:

- (a) Boss Catalogue star number, Henry Draper star number (3,335 cards).
- (b) Boss Catalogue star number, Henry Draper star number, FK3 star number, Durchmusterung number (33,342 cards).
- (c) Same as 4 (b) but in order of Henry Draper number. Magnetic tape only.

Star Catalogues

Available

(7) Yale Observatory Catalogues

Declinations °	Cards	Declinations °	Cards
+ 85 to + 90	$\left\{ \begin{array}{l} X = 1,031 \\ Y = 1,031 \\ \alpha = 1,031 \\ \delta = 1,031 \end{array} \right.$	- 2 to + 1	5,583
+ 55 to + 60	8,164	- 2 to - 6	8,108
+ 50 to + 55	8,380	- 6 to - 10	8,248
+ 25 to + 30	10,358	- 10 to - 14	8,101
+ 20 to + 25	8,703	- 14 to - 18	8,563
+ 15 to + 20	9,092	- 18 to - 20	4,553
+ 10 to + 15	8,967	- 20 to - 22	4,292
+ 9 to + 10	1,906	- 22 to - 27	15,110
+ 5 to + 9	9,060	- 27 to - 30	9,455
+ 1 to + 5	7,996	- 30 to - 35	} Magnetic tape only.
		- 35 to - 40	
		- 40 to - 50	
		- 70 to - 90	

(8) Yale Catalogue of Bright Stars (Third Revised Edition, 1964). Magnetic tape only.

(9) Yale, *General Catalogue of Trigonometric Stellar Parallaxes*, 1952 (6,079 cards).

(10) Wilson, *General Catalogue of Stellar Radial Velocities*, 1953 (15,106 cards).

(11) *Henry Draper Catalogue and Extension*, Harvard Observatory Annals Vols. 91 - 100 (272,150 stars). Magnetic tape only.

(12) Smithsonian Astrophysical Observatory, *Star Atlas*. Magnetic tape only.

(13) FK3

(a) Right ascension (1,591 cards).

(b) Declination (1,591 cards).

(14) FK4 (1,535 cards).

(15) AGK2

Declinations °	Cards	Declinations °	Cards
+ 70 to + 89	11,801	+ 25 to + 29	14,367
+ 60 to + 69	13,064	+ 20 to + 24	12,992
+ 55 to + 59	8,535	+ 15 to + 19	12,857
+ 50 to + 54	9,168	+ 10 to + 14	14,330
+ 45 to + 49	10,915	+ 5 to + 9	16,770
+ 40 to + 44	11,806	0 to + 4	15,094
+ 35 to + 39	12,337	0 to - 2.5	7,157
+ 30 to + 34	12,395		

(16) *Geschichte des Fixsternhimmels*, δ 0° to +90°, for 1875 (tape only).

(17) Kustner, Catalogue of 10,663 Stars. Bonn, Vol. 10, δ 0° to +51° (10,663 cards).

Star Catalogues

Available

(18) Berlin, Vol. 55, AGK2A (13,747 cards).

(19) *Cape Zone Catalogue for 1900*

(a) $\delta - 40^\circ$ to -52° (20,843 cards).

(b) Also precessed to 1950.0 (20,843 cards).

(20) *Cape Photographic Catalogue for 1950*

Declinations °	Cards	Declinations °	Cards
- 30 to - 35	12,846	- 64 to - 68	5,398
- 35 to - 40	12,115	- 68 to - 72	4,503
- 52 to - 56	9,215	- 72 to - 76	3,764
- 56 to - 60	7,657	- 76 to - 80	2,934
- 60 to - 64	77,053	- 80 to - 90	Magnetic tape only.

(21) First Cape Catalogue for 1925 (4,569 cards).

(22) Second Cape Catalogue for 1925 (11,667 cards).

(23) Third Cape Catalogue for 1925, $\delta 0^\circ$ to -30° (6,597 cards).

(24) First Cape Catalogue for 1950 (5,070 cards).

(25) Semiot, Bordeaux Meridian Circle Observations, $\delta +11^\circ$ to $+18^\circ$ (2,024 cards).

(26) Fayet, Meridian Circle at Nice, $\delta +5^\circ$ to $+15^\circ$ (964 cards).

(27) Fayet, *Catalogue et Mouvements Propres*, $\delta -5^\circ$ to $+5^\circ$ (1,020 cards).

(28) Toulouse Annals, Vol. XIII, Third Catalogue of Toulouse (10,070 cards).

(29) Kukarkin, *General Catalogue of Variable Stars*

(a) Second edition (14,708 cards).

(b) First supplement to the second edition:

(1) (1,647 cards).

(2) (796 cards).

(30) Boss, *San Luis Catalogue*, for 1910 (15,333 cards).

(31) Cordoba, *Fundamental General Catalogue for 1950.0* (761 cards).
Supplement (231 cards).

(32) Cordoba B, Vol. 23, $\delta -27^\circ$ to -32° (15,200 cards).

(33) Larink, *Katalog Schwacher Sterne*, 1950 (3,356 cards).

(34) *Albany Catalogue for 1910.0* (20,811 cards).
Appendix (1,125 cards).

(35) Boss, *Preliminary General Catalogue of 6,188 Stars for 1900* (6,188 cards).

(36) *Cape Fundamental Catalogue for 1900* (1,293 cards).

(37) *Second Cape Fundamental Catalogue for 1900* (1,846 cards).

(38) *Cape General Catalogue for 1900* (4,464 cards).

(39) *Cape General Catalogue of 1,680 Stars for 1900* (1,680 cards).

Star Catalogues

Available

- (40) Moscow Universitet Soobshchenia No. 97 - 98, Catalogue of Faint Stars (545 cards).
- (41) *Lund Observatory Annals* No. 11, Meridian Observations of Faint AG Stars (6,099 cards).
- (42) Brorfelde Meridian Observations, 1964 - 1967 (972 cards).
- (43) AGK3. Magnetic tape only.
- (44) First Greenwich Catalogue of Stars for 1950.0, Parts I and II. Magnetic tape only.
- (45) Publications of Cincinnati Observatory, No. 22 (2,300 cards).
- (46) Bonn Catalogue of Intermediary Stars, + 50° to + 90° (1,823 cards).
- (47) Leiden Annals, Vol. XV, No. I (1,533 cards).
- (48) Publications of Pulkovo, Series II
 - (a) Vol. XLIX, Observations in α (1,904 cards).
 - (b) Vol. LVII, Observations in δ (1,904 cards).
- (49) Photographic Zenith Tube (PZT) Catalogs (1950.0)
 - (a) Washington, D. C., 120 stars (120 cards).
 - (b) Richmond, Fl., 91 stars (91 cards).
- (50) Danjon Astrolabe Catalogs (1950.0)
 - (a) Washington, D. C., 250 stars (250 cards).
 - (b) Richmond, Fl., 250 stars (250 cards).

In Preparation

- (51) *Astronomical Papers*, Vol. VIII, Part III (1,607 cards).
- (52) *Astronomical Papers*, Vol. X, Part I (1,504 cards).
- (53) Publications of Pulkova Observatory, Vol. LXII
 - (a) Left hand pages (587 cards).
 - (b) Right hand pages (587 cards).
- (54) *Second Catalogue de l'Observatoire de Bordeaux* (7,038 cards).
- (55) Leiden Annals Vol. XV, No. 4, General Catalogue of 1,190 Standard Stars (1,190 cards).
- (56) Publications of Cincinnati Observatory, No. 19 (4,683 cards).
- (57) Second Cape Catalogue for 1950 (6,763 cards).
- (58) Lund Annals, No. 13 (1,190 cards).
- (59) Ann. de l'Observatoire de Belgique (1,339 cards).

Miscellaneous

- (1) Sidereal Time, through 1980 (366 cards per year).
- (2) Equation of Time for 0^h U. T., 1965 - 1977 (62 cards per year).
- (3) Nutation in longitude and obliquity, 1949 March 25 through 2009 June 18 (365 cards per year).
- (4) Besselian and Independent Day Numbers
 - (a) referred to equinox of 1950.0, 1960 - 1971 (365 cards per year).
 - (b) referred to nearest beginning of a year, 1960 - 1971 (365 cards per year). 1972 - 1979. Magnetic tape only.
- (5) *The Nautical Almanac*, 1964 through 1976
 - (a) Left hand pages: Greenwich hour angle and declination of Venus, Mars, Jupiter and Saturn, hourly; sidereal hour angle and declination of 57 stars for every third day (9,000 cards per year).
 - (b) Right hand pages: Greenwich hour angle and declination of Sun and Moon, hourly; sunrise - sunset, civil and nautical twilight, moonrise - moonset (9,000 cards per year).
- (6) *The Air Almanac*, 1964 - 1976 (53,000 cards per year).
- (7) Variation of Latitude (determined by PZT)
 - (a) Washington, D. C., 1915 to date, daily values. Magnetic tape only.
 - (b) Richmond, Fl., 1949 to date, daily values. Magnetic tape only.
- (8) Variation of Longitude (determined by PZT)
 - (a) Washington, D. C., 1935 to date, daily values. Magnetic tape only.
 - (b) Richmond, Fl., 1949 to date, daily values. Magnetic tape only.
- (9) Atomic Clock Intercomparison Data (Washington, D. C.)
 - (a) 1969 - 1972, 3^h interval. Magnetic tape only.
 - (b) 1972 to date, hourly values. Magnetic tape only.
- (10) Precise Time Comparisons (accurate to 1μ sec) 1972 to date, daily values. Magnetic tape only.

Coordinates

Geocentric equatorial spherical

Sun (1a) (2) (5a) (5b) (6) (7)
Moon (1b) (2) (7a) (7b) (8)
Planets (1a) (1b) (1c) (12a) (12b) (13) (15)
Minor Planets (1a) (1b)
The Nautical Almanac [Miscellaneous (4a) (4b)]
The Air Almanac [Miscellaneous (5)]

Geocentric equatorial rectangular

Sun (3b)
Moon (3a) (3b)

Geocentric ecliptic spherical

Sun (1b) (3b)
Moon (1a) (4) (5)

Heliocentric equatorial rectangular

Earth - Moon barycenter [Sun (3a)]
Planets (2a) (2b) (2c) (2d) (3) (4b) (4c) (4d) (5)
(8a) (8b) (9a) (9b) (11a) (11b) (14)
Minor Planets (2) (3)

Heliocentric ecliptic spherical

Earth - Moon barycenter [Sun (3a)]
Planets (1d) (1e) (4a) (8b) (10)